Airport Capacity Enhancement

Tactical Initiative

LaGuardia Airport

Effects of B777-200 Folding-Wing Aircraft on Airfield Operations

B777 taxi test at Paine Field, Everett, WA, 1994

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LaGuardia Airport New York, New York

November 1994

Prepared jointly by the U.S. Department of Transportation, Federal Aviation Administration, the Port Authority of New York and New Jersey, and the Air Transport Association.

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Summary

The purpose of this study was to examine the impact of the introduction of the Boeing 777 folding wing aircraft on navaids, operating minimums, air traffic control, capacity, efficiency, and safety at New York's LaGuardia Airport (LGA). The Boeing 777-200 folding-wing aircraft will be able to operate at LaGuardia Airport with much the same effect on airport operations as any other "heavy" aircraft introduced there, except as noted below.

- The Boeing 777-200 is a heavier aircraft — runway and taxiway pavements and runway decks may have to be strengthened. The Port Authority is investigating.
- The new aircraft carries about 100 more passengers per flight — a longer turn around time will be needed to load, unload, and service the aircraft. This increase in gate service time is not expected to have a significant impact on delay.
- The folding and unfolding of the wing results in slightly longer runway occupancy times — but the effect on airport capacity is relatively minor, and the operational effect may be offset by the increased passenger capacity.
- If Cat II operations are eventually conducted at LaGuardia, there may be a condition prohibiting the operation of the B777 on close parallel taxiways with it's wings folded during Cat II operations. This is indicated by Collision Risk Model results which did not show an acceptable level of safety for this condition. Therefore, to accommodate this aircraft at LGA during Cat II operations, it may be necessary to establish special ground handling procedures such as mandatory taxi routes, remote holding or remote gates, during the infrequent Cat II periods.
- These items require further study:
- Effect of the reflective surfaces presented by the tail and folded-wingtips of the Boeing 777-200 on air navigation facilities. This study, if conducted, should be coordinated with the FAA's Airway Facilities organization.
- Pavement and deck strengths.
- Taxiway fillets.

At first glance, none of the items above appear to be insoluble, however, the issue of pavement and deck strengthening is a major one which must be thoroughly investigated. The study, therefore, concluded that, relative to the issues considered, the Boeing 777-200 folding wing aircraft can be accommodated at LaGuardia, subject to the results of the additional studies indicated.

Introduction of the B777 at LaGuardia appears to have significantly less impact on delay than increasing the traffic levels by 25 or 50 operations per day.

Introduction

Objective

This study was initiated by the Port Authority of New York and New Jersey and the Federal Aviation Administration (FAA) to evaluate the impact on airfield operations of the introduction of the Boeing 777-200 folding-wing aircraft at New York's LaGuardia Airport (LGA). The study examined effects on NAVAIDs, operating minimums, air traffic control, capacity, efficiency, and safety.

Background

Since 1985, the FAA has sponsored Airport Capacity Design Teams at airports across the country affected by delay. Representatives from airport operators, air carriers, other airport users, and aviation industry groups work together with FAA representatives to identify and analyze capacity problems at each individual airport and recommend improvements that have the potential for reducing delays. The improvements recommended by the Capacity Teams have emphasized construction of new runways and taxiways, installation of enhanced facilities and equipment, and changes in air traffic control procedures. Typically, these solutions are addressed through established, long-term planning processes.

The FAA's Office of System Capacity and Requirements (ASC) has undertaken a series of initiatives to identify, evaluate, and implement capacity improvements that are achievable in the near term and will provide more immediate relief for chronic delay-problem airports. Airport Capacity Enhancement (ACE) Action Teams will be established at selected airports, again made up of representatives from airport operators, air carriers, other airport users, FAA, and aviation industry groups, to assess these near-term, tactical initiatives and guide them through implementation. Strengthening of runways and adjustment of airfield layout to permit the introduction of larger aircraft represents one of the best potentials for increasing passenger accommodation, particularly at congested airports which cannot be expanded.

The Boeing 777 aircraft will have a wingspan of just under 200 feet. Boeing is considering an optional folding-wing design that will reduce the aircraft's wingspan on the ground to about 155 feet, or approximately the wingspan of a Boeing 767. This would permit the aircraft to operate at tight-geometry airports like LaGuardia. Prior to initiating this study, it was agreed that the fixed-wing version of the aircraft could not be accommodated at LaGuardia Airport.

Boeing began conceptual design of the Boeing 777 in 1990. The new aircraft will be a widebody twin jet with a maximum gross takeoff weight of about 590,000 pounds (later, stretched versions of the aircraft may have a maximum gross takeoff weight as high as 650,000 pounds). It could be able to carry about 400 passengers for distances up to 4,000 nautical miles. LaGuardia, however, has a 1,500 sm perimeter rule (service to Denver is grandfathered from this rule). The aircraft flew as a prototype in the spring of 1994, with first deliveries expected in May 1995. Although this schedule is probably optimistic, depending on orders, the aircraft will be in service before the year 2000. Boeing has no commitment to build the B777-200 with a folding wing at this time.

Scope

The ACE Action Team concentrated its analysis on operational and efficiency aspects on the airside of the airport, including gates, runway and taxiway system, close-in approach and departure segments, and the airway facilities necessary to make the airport function. They considered the technical feasibility of the proposed improvements, but did not address environmental and design issues or the cost of development and construction. These issues need to be addressed in future airport planning studies, and the data generated in this study can be used in these follow-on studies. Other aspects, to include safety, were analyzed by individual divisions to make the report complete.

Methodology

The ACE Action Team, which included representatives from the FAA, the Port Authority of New York and New Jersey, and various aviation industry groups (see Appendix A), met periodically for review and coordination. The ACE Action Team considered various operational alternatives proposed by the members of the team. Based on the combined experience and judgment of the team, alternatives that were considered practicable were developed into experiments that could be tested by simulation modeling. The FAA Technical Center's Aviation Capacity Branch provided expertise in airport simulation modeling. The ACE Action Team validated the data used as input for the simulation modeling and analysis and reviewed the interpretation of the simulation results. The data, assumptions, alternatives, and experiments were continually reevaluated, and modified where necessary, as the study progressed. Data input and assumptions can be found in Appendix B.

Initial work consisted of gathering data and formulating assumptions required for the capacity and delay analysis and modeling. Where possible, assumptions were based on actual field observations at LGA. Alternatives proposed by the ACE Action Team were analyzed with the help of computer models. The Collision Risk Model was used in a combined effort by Flight Standards and Airports to assess effects on airport standards and operational surfaces, i.e., safety. The Airport Machine was used to evaluate operational effects that might lead to delays or loss of efficiency on the ground. Appendix C briefly explains the models.

Findings

Figure 1. LaGuardia Airport — Existing Configuration

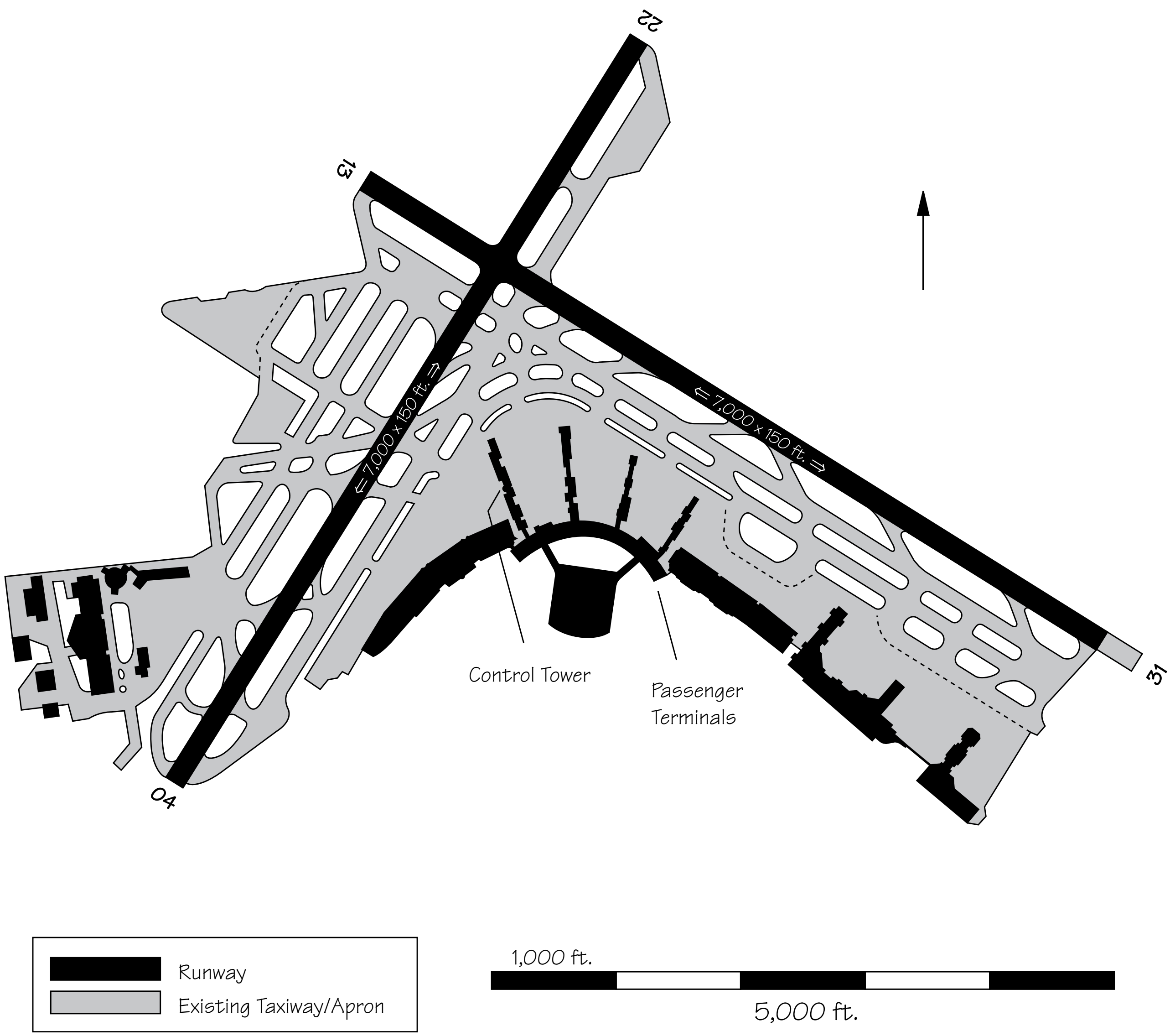


Figure 2. LaGuardia Airport — Future Configurtation

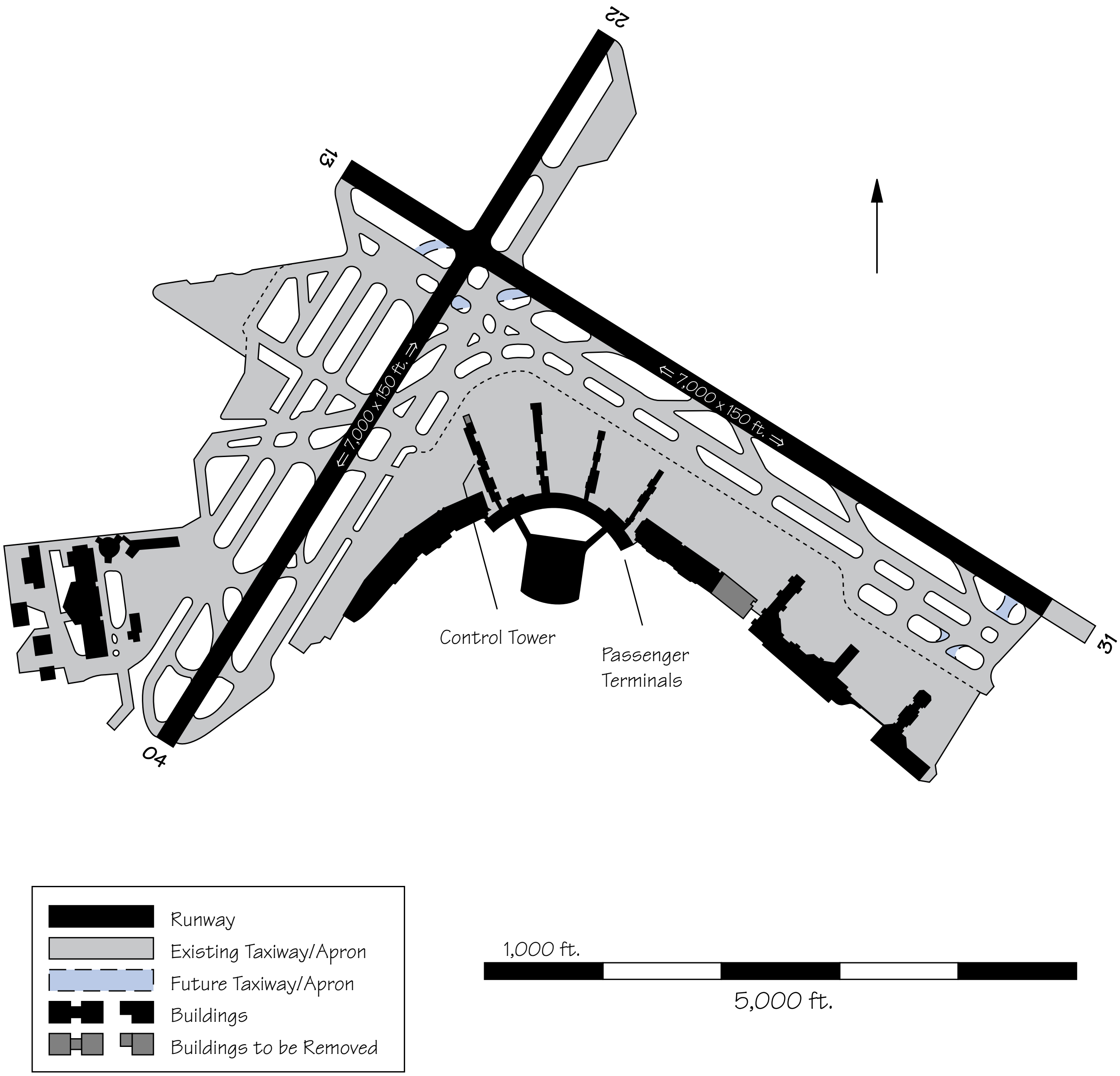


Figure 1 shows the current layout of the airport. In studying the impact of the introduction of the Boeing 777-200 folding-wing aircraft on airport operations, the Airport Capacity Enhancement Action Team developed the following conclusions.

Effect on Safety

Flight Standards Division conducted an evaluation of the Boeing 777. Their analysis indicated that the Boeing 777 would have about the same effect as any other widebody aircraft at the airport, which all operate within an acceptable envelope of safety for Category I (CAT I) conditions.

Effect on Minimums

Introduction of the Boeing 777-200 folding-wing aircraft will not affect current landing or departure minimums at LaGuardia Airport. However, in the folded position, with the aircraft on the close parallel taxiway, the vertical height of the wingtip of the Boeing 777-200 (46 feet 8 inches) does not stay within the 1 to 10 million collision risk curve for CAT II operations at LaGuardia. LaGuardia is not currently equipped for CAT II operations, but the FAA and the airport operator are protecting for eventual CAT II operations based on the prospect of future technology. If CAT II operations are eventually conducted at LaGuardia, there may be a condition prohibiting the operation of the B777 on close parallel taxiways with it's wings folded during CAT II operations. Therefore, to accommodate this aircraft at LGA during CAT II operations, it may be necessary to establish special ground handling procedures such as mandatory taxi routes, remote holding or remote gates, during the infrequent CAT II periods.

Effect on NAVAIDs

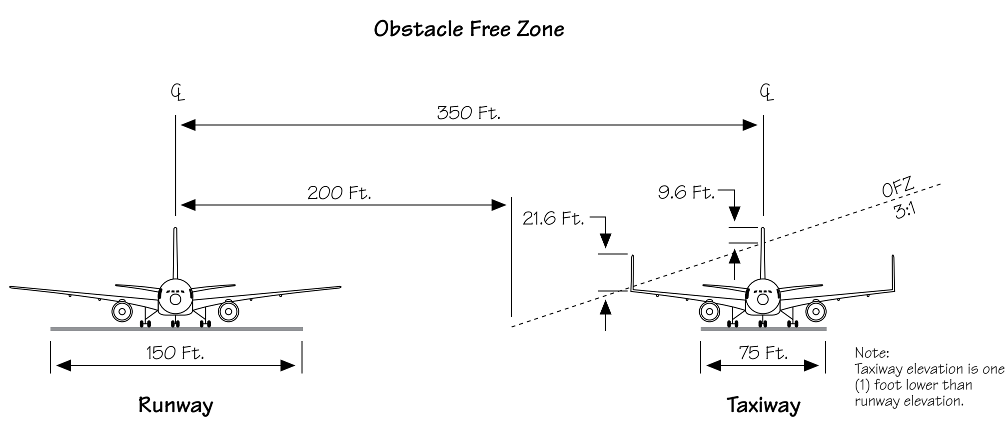
As far as can be determined, the Boeing 777-200 will have about the same effect on NAVAIDs as any other widebody aircraft. However, Airway Facilities Division recommends that a recognized expert in the field of NAVAID interference study the reflective surfaces presented by the tail and folded-wingtips of the Boeing 777-200. The Boeing Commercial Airplane Company will coordinate this study with the FAA and the Port Authority. The facilities and equipment under consideration are the VHF omnidirectional range (VOR), the instrument landing system (ILS) localizers and glide slope, and the runway visual ranges (RVRs).

Effect on Airport Standards

LaGuardia Airport was built to older standards that were less demanding than today's airport standards. The airport meets the requirements of Federal Aviation Regulation (FAR) Part 139 through grandfathering provisions and a series of waivers. These waivers were granted only after intense study to preserve an equivalent level of safety.

An Obstacle Free Zone (OFZ) protects arriving and departing aircraft from fixed and movable aircraft adjacent to the runway. With a folded-wingtip height of 46.67 feet above the ground, a Boeing 777-200 on the airport's parallel taxiways would penetrate the OFZ by 21.5 feet when on the parallel taxiway centerline and by 27 feet when the main gear is on the taxiway edge (see Figure 3).

Figure 3. Boeing 777-200 on LaGuardia Runway and Parallel Taxiway



For CAT I, the analysis with the Collision Risk Model indicated a less than 1 in 10 million chance of collision, and, therefore, the Boeing 777-200 would not be considered a safety hazard in the OFZ. While the folded wingtip of the aircraft penetrates a generalized line representing the OFZ, it does not encroach on the actual elliptical operational surface. The Boeing 777-200 aircraft with its wings folded is, therefore, comparable to any other widebody aircraft.

Effect on Ground Operations

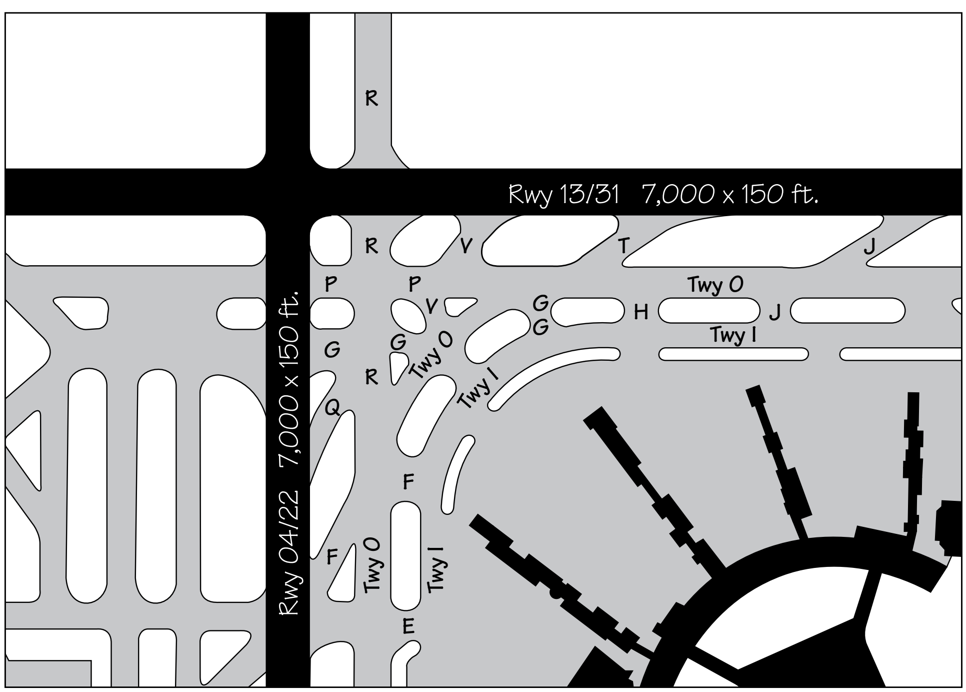
The runway and taxiway system for LaGuardia Airport is shown in Figure 1. Boeing 777-200 folding-wing aircraft must avoid conflict with aircraft on the adjacent runways and taxiways. The following aspects of ground operations were considered by the ACE action team.

- Arriving aircraft exiting the runways.
- Departing aircraft entering the runways.
- Radius of taxi turns.
- Aircraft gates.

Arriving Aircraft

A section of the parallel taxiways, currently called Taxiway I (Inner) and Taxiway O (Outer), between Taxiway J and Taxiway E, is separated by only 200 feet, as shown in Figure 4. In this critical section, the Boeing 777-200 folding-wing aircraft will not be able to exit the runway and occupy the Outer Taxiway with another widebody on the Inner Taxiway unless its wings are folded. Boeing 777-200 folding-wing aircraft landing on Runway 31, therefore, cannot exit the runway at Taxiways J or T with wings unfolded, nor can aircraft landing on Runway 4 exit at Taxiway F with wings unfolded. Exits at Taxiways J and F are not likely because of available runway length (3,600 feet), but 50 percent of arriving aircraft could exit at Taxiway T (4,600 feet).

Figure 4. Parallel Taxiways separated by 200 feet.



All this leads to the conclusion that Boeing 777-200 aircraft arriving on Runway 31 cannot exit the runway with wings unfolded. Folding the wings while still on the runway would increase runway occupancy times and reduce the probability of exits at Taxiway T. An investigation will be conducted to determine the geometry of Taxiway V so as to provide the required fillet to accommodate the B-777-200 aircraft exiting Runway 31. In either case, the relatively minor increased runway occupancy times would not affect operational capacity. Because of wake-vortex separation requirements, the aircraft that follows the Boeing 777 will take a longer time to arrive at the runway, thus giving the lead aircraft more time to fold its wings before exiting.

All other taxiways are single taxiways or involve taxiways at least 235 feet apart, which do not present a problem for exiting aircraft.

Departing Aircraft

Boeing 777-200 folding-wing aircraft departing on Runway 13 will unfold their wings between the intersection of Taxiways P and G and the end of the runway (see Figure 5). Departure runway occupancy time is not expected to be affected. At Runway 22, there is no bypass capability available. The wings of the B-777-200 can be extended at the Runway 22 hold line prior to entering the runway. Departure runway occupancy time is not expected to be affected.

Boeing 777-200 folding-wing aircraft departing on Runway 31 will be able to unfold their wings on Taxiway M (see Figure 6). There will be no effect on departure runway occupancy time.

Boeing 777-200 folding-wing aircraft departing on Runway 4 will not be able to unfold their wings at the hold line designed to protect arrivals on Runway 4 (see Figure 7). The aircraft must wait to unfold their wings until they are past the blast fence, leaving them with about 500 feet of taxiway or about 30 seconds of taxi time. This will not affect departure runway occupancy time when the runway is used for departures only. It could increase departure runway occupancy time by ten seconds when Runway 4 is used for both arrivals and departures. Arrival-to-arrival intervals would have to be increased by this amount of time, and increased air traffic control (ATC) coordination would be required. The Port Authority will investigate placing signs at the east and west existing blast fences alerting pilots of B-777 aircraft not to extend the aircraft's wings until they are past the blast fence.

Figure 5. Runways 13 and 22 Departure Access.

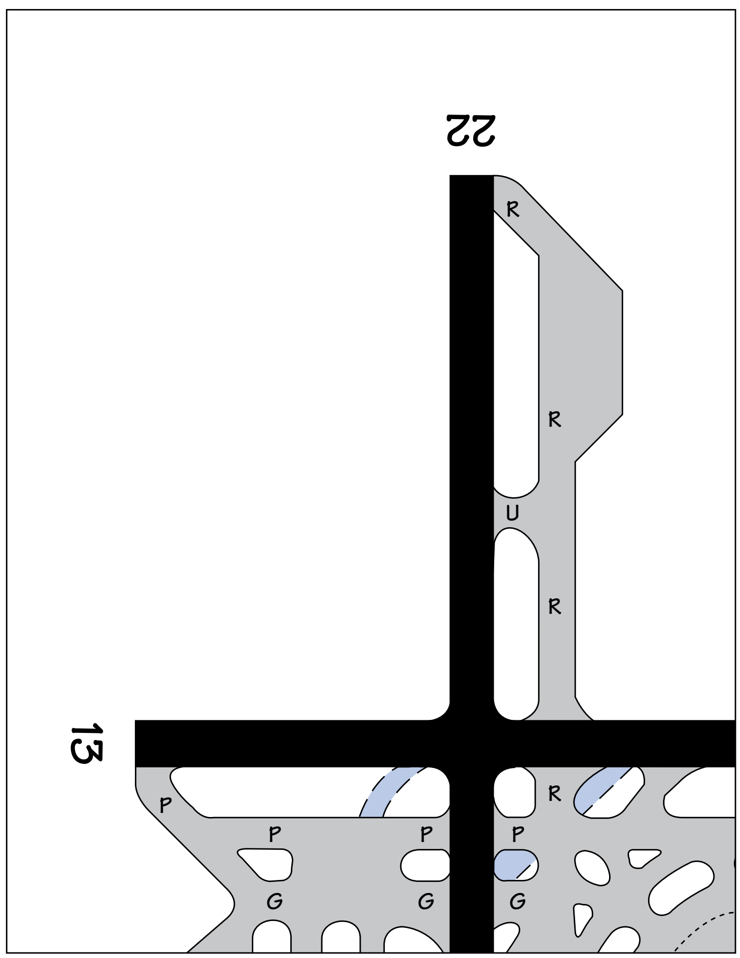


Figure 6. Runway 31 Departure Access.

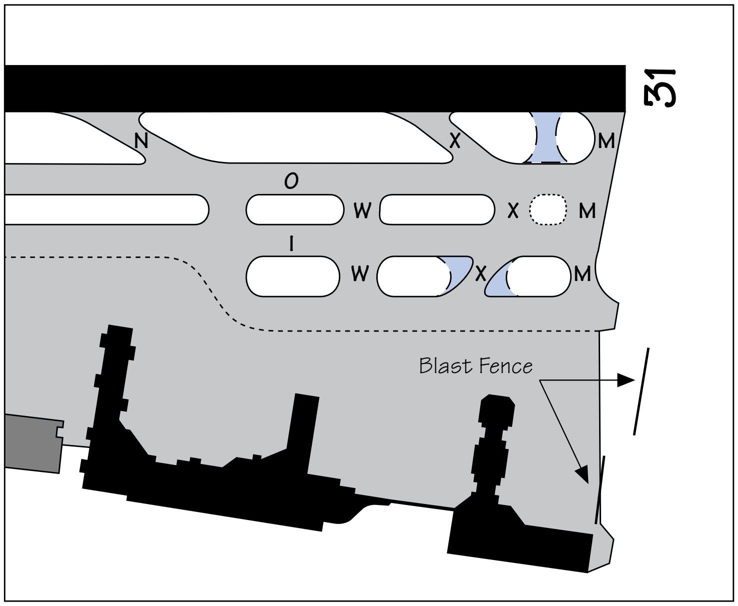
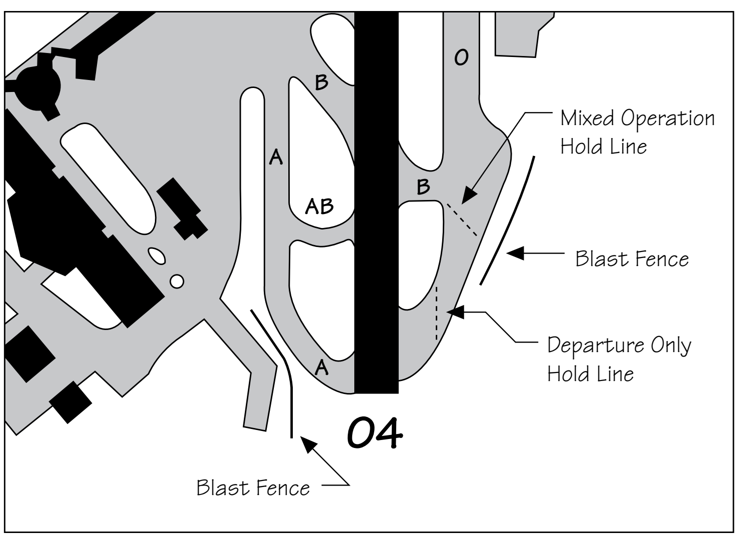


Figure 7. Runway 4 Departure Access.



Effect on Pavement

Taxiway Fillets

There are many taxiway turns on the existing airport that may be difficult for the Boeing 777 folding-wing aircraft to negotiate. The Port Authority will investigate the widening of taxiway fillets (see Figure 8).

Pavement Strengths

Figure 9 depicts pavement specifications for LaGuardia Airport. The ability of the pavement to support the Boeing 777-200 aircraft is currently being investigated by the Port Authority using the Boeing 777 gear configurations (See Figures 10 and 11). Strengthening of the runway decks, runway and taxiway pavement, evaluation of pavement castings (manhole covers, manhole boxes, etc.) are also being investigated.

Effect on Aircraft Gates

The length of this aircraft in relation to wide body aircraft currently at LGA will cause the following effects at aircraft gates:

- Relocation of loading bridges.
- Expansion of hold rooms.
- Downsizing of adjacent hold rooms and aircraft gates.

Figure 8. LaGuardia Airport Taxiway Fillets.

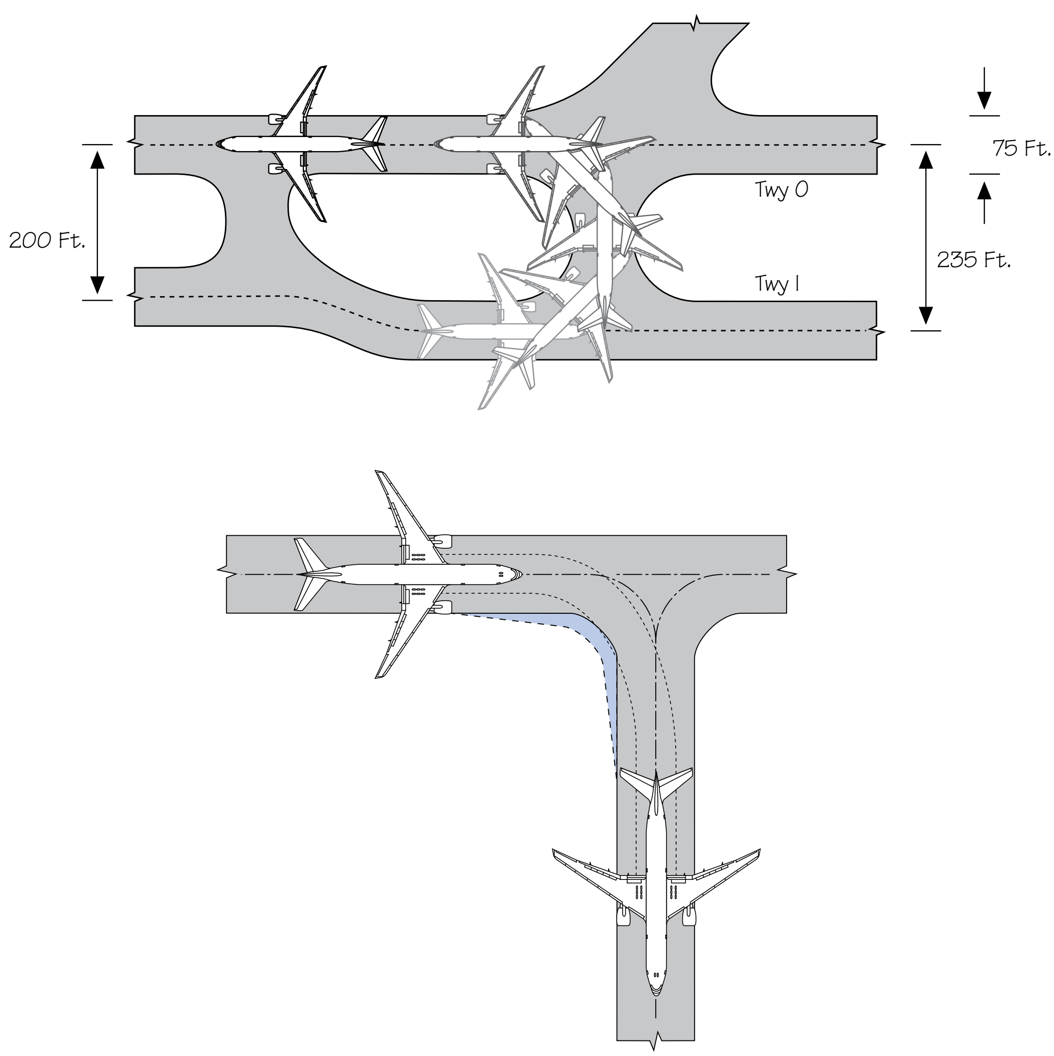
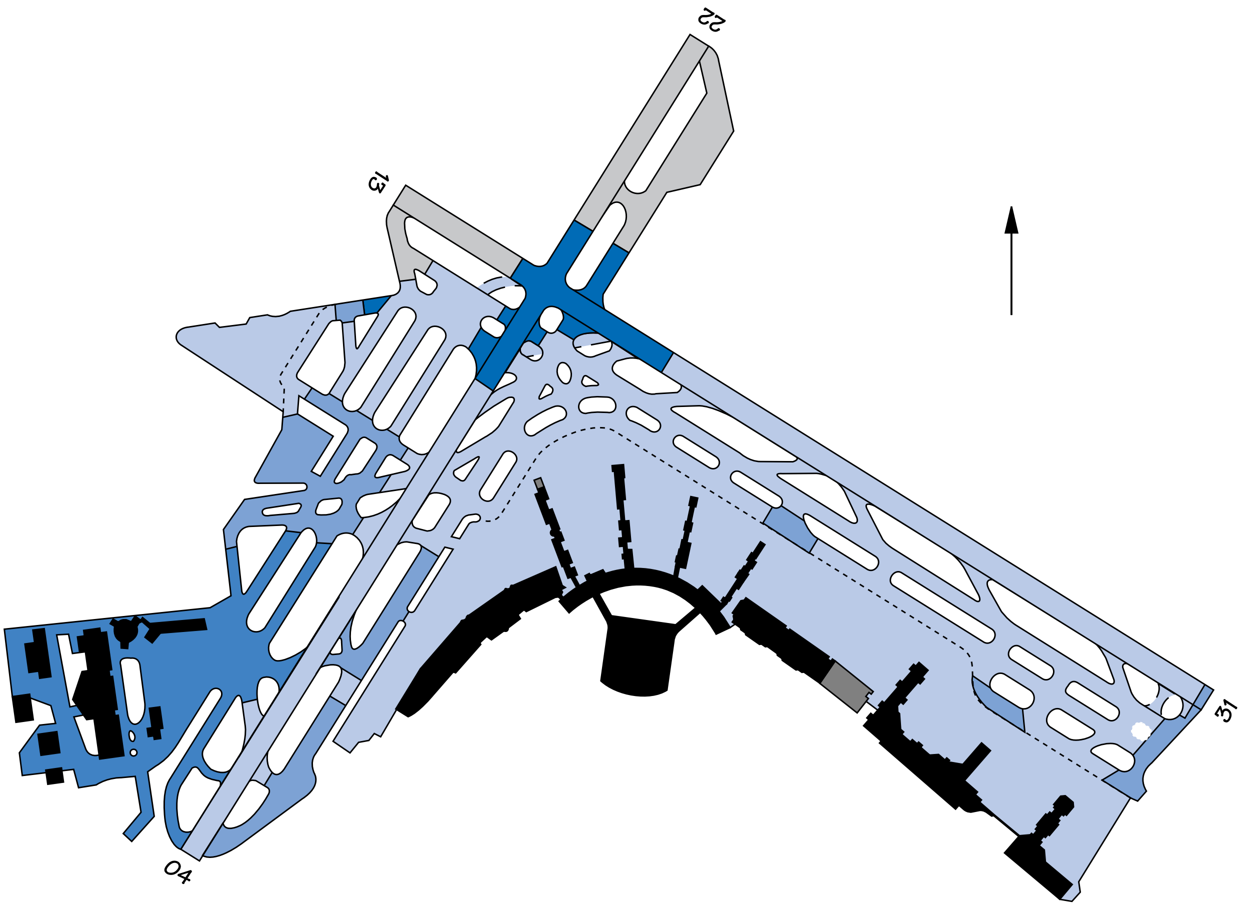


Figure 9. LaGuardia Airport Pavement Sections.



Pavement Type	Plan Design	Total Depth*	Sub-Base (S)	Base (M)	Top (AC)	Overlay (AC)
Asphalt & Concrete	A-1	29" - 37"	4"	4"	4"	13" - 22"
	A-2	20" - 28"	6"	4" - 6"	4"	6" - 11"
	A-3	13" - 19"	6"	3" - 8"	2" - 4"	3" - 8"
	A-4	13" or less	6"	3" - 8"	2"	2" - 4"
Concrete Structure	C-1	—	Prestressed		—	—
	C-2	—	Non Prestressed		—	—

* Includes Overlay

Abbreviations:
(AC) = Asphalt Concrete; (M) = Macadam; (S) = Crushed Stone

Figure 10. Boeing 777 Main Landing Gear — Port Wheel Assembly

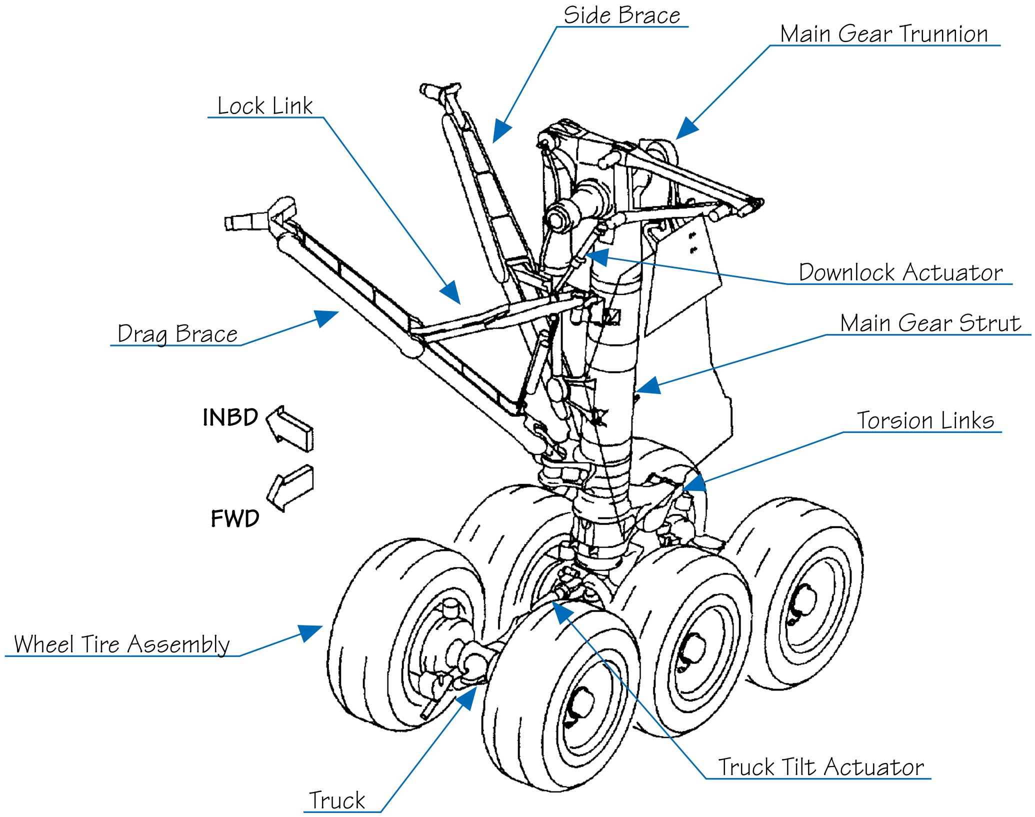
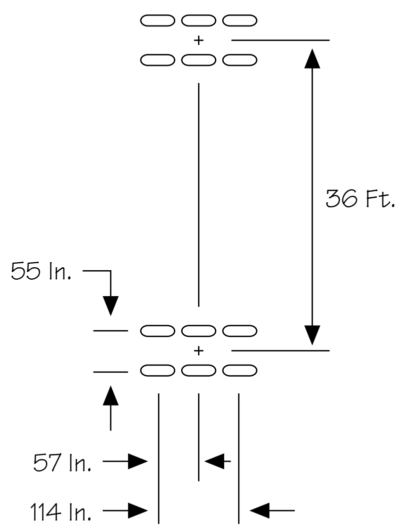


Figure 11. Boeing 777-200 Main Landing Gear Footprint



Appendix A

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Appendix B

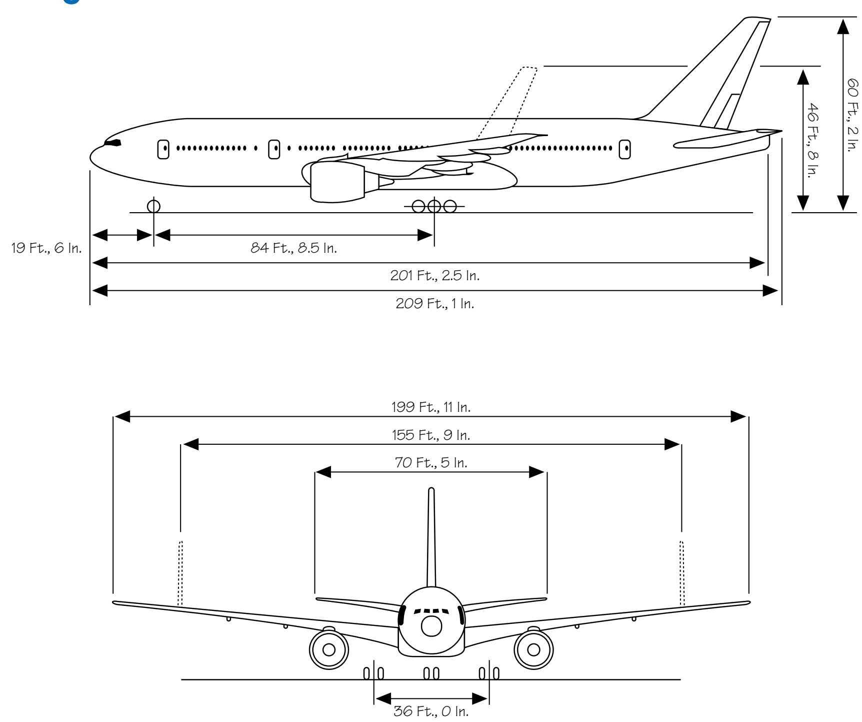
Data Inputs and Assumptions

Aircraft Characteristics

The aircraft characteristics used for the study analysis are as described in the Boeing Commercial Airplane Group publication DC-58329, *777 Airplane Characteristics for Airport Planning*, dated February 1992. The fixed-wing Boeing 777 cannot be accommodated at New York's LaGuardia Airport. Aircraft passenger capacity is assumed to be 375 passengers. Aircraft dimensions are depicted in Figure 12.

Maximum gross takeoff weight (*7,000 ft. runway at sea level*) .... 500,000 lbs.
Maximum range (*500,000 lbs. and maximum payload*) ....4,200 nm
Maximum payload (*500,000 lbs with 1,500 nm perimeter rule*) .... 420,000 lbs.

Figure 12. Boeing 777 Aircraft Dimensions.



Aircraft Gates

LaGuardia Airport is divided into three terminal areas, the Central Terminal Area, the East End Terminal Area, and the Marine Terminal Area. Based on a preliminary analysis by the Port Authority of New York and New Jersey, the gates indicated at the Central Terminal Area in Figure 13 and at the East End Terminal Area in Figure 14 can accommodate Boeing 777-200 folding-wing aircraft.

The Central Terminal Area, with 37 gates, provides service for American Airlines, United Airlines, Air Canada, Trans World Airlines, and other miscellaneous air carriers, which account for about 40 percent of the total daily operations at LaGuardia. The East End Terminal Complex, with 28 gates, provides service for USAir, USAir Shuttle, Delta Air Lines, and Northwest Airlines, which account for about 50 percent of the total daily operations.

The Marine Terminal Area, located west of Runway 4/22, has six gates and provides service for the Delta Shuttle. None of the gates at the Marine Terminal Area can accommodate the Boeing 777-200 aircraft.

Figure 13. Possible Boeing 777-200 Gates at the Central Terminal Area.

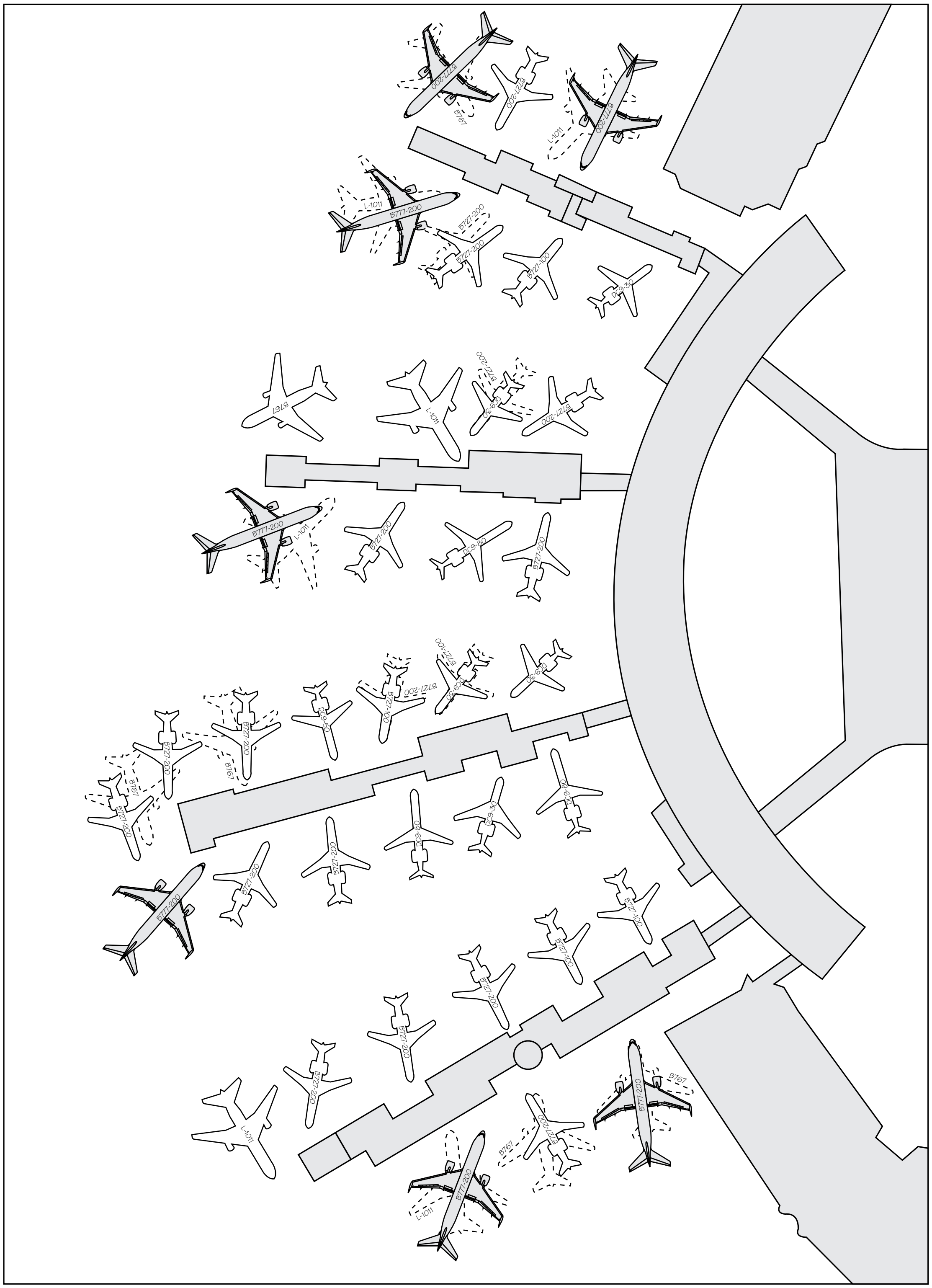


Figure 14. Possible Boeing 777-200 Gates at the East End Terminal Area.

Aircraft Activity

Figure 15 shows the daily and annual number of operations for each of the three activity levels used in the study. The figure also indicates the number of Boeing 777 aircraft operations modeled at each activity level. Figure 16 illustrates the hourly profile of daily demand the Baseline (1992) and Future 2 (2003) levels of aircraft operations. Airfield demand levels reflect takeoff and landing slot constraints regulated by the high density rule.

Figure 15. Airfield Demand Levels.

Year	Annual	24-Hour Day	Number of B777 Per Day
1992	252,100	1,000	0
1998	264,200	1,025	0,3,6
2003	270,200	1,050	6,9,12

Figure 16. Profile of Daily Demand — Hourly Distribution.

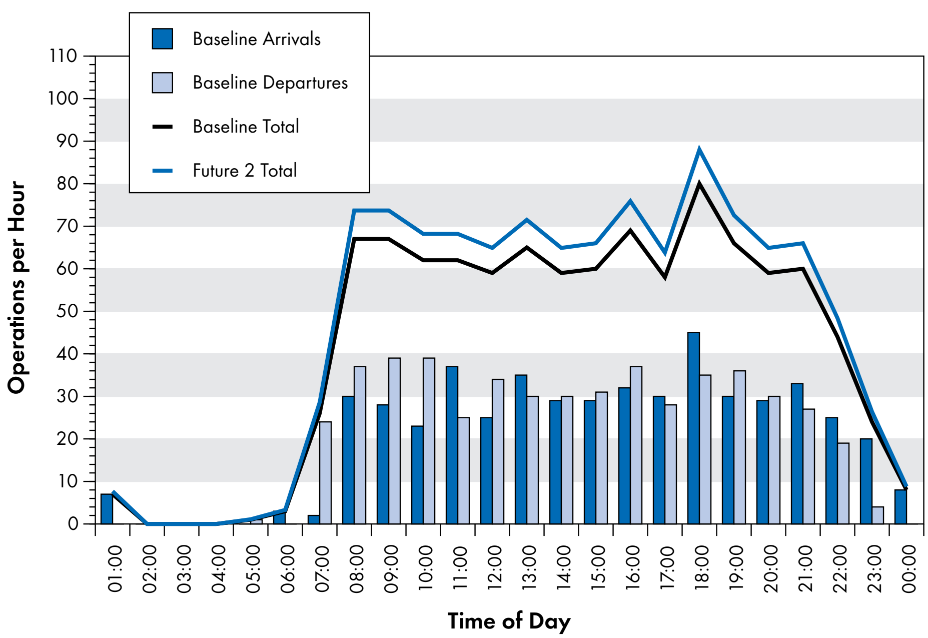


Figure 17. Current and Forecast Departures by Passenger Aircraft Type.

Acft.	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
100	1,676	4,671	5,814	6,024	6,216	6,407	6,598	6,789	6,981	7,172	7,363	7,554	7,746
320	1,223	2,723	6,170	7,174	7,575	8,095	8,570	8,550	9,058	9,167	9,475	9,583	9,892
72S	31,882	46,053	48,585	45,845	45,537	42,169	40,356	36,821	34,310	30,518	27,335	23,108	17,019
733	8,440	15,467	15,951	16,306	16,410	16,558	17,206	17,854	18,502	19,056	19,556	20,056	21,000
734	2,896	4,473	5,380	5,844	6,000	7,032	7,476	8,217	8,217	8,217	8,217	8,217	8,217
735	0	0	0	0	0	0	0	0	0	0	0	100	1,000
73S	10,244	7,499	7,410	5,685	5,430	5,430	5,430	5,430	5,430	5,430	5,430	5,430	5,176
757	9,496	9,140	8,475	9,666	10,464	11,388	11,731	12,735	13,253	14,122	14,595	15,451	16,515
763	2,508	2,536	2,536	2,536	2,536	2,536	2,536	2,536	2,536	2,600	3,000	3,200	3,300
767	1,799	1,924	2,208	2,478	2,678	2,978	4,668	6,098	6,413	7,213	9,298	9,978	10,548
AB3	6	114	365	365	365	365	365	365	365	365	365	365	365
D10	2,876	1,739	1,065	1,065	1,022	848	326	283	261	217	217	217	152
DC9	15,269	14,298	12,001	8,788	6,734	6,076	5,500	4,447	4,047	3,945	3,852	3,806	3,713
F28	2,293	1,844	1,271	1,271	1,271	1,080	1,017	921	890	794	731	731	731
L10	1,588	2,490	1,825	1,825	1,825	1,792	1,560	1,294	763	630	498	365	332
M80	7,616	12,005	12,221	13,613	14,999	17,590	18,287	19,414	20,964	22,514	22,537	23,937	26,367
M90	0	0	0	0	0	0	0	300	1,250	2,000	2,000	2,500	3,000
Total	99,812	126,976	131,277	128,485	129,062	130,344	131,626	132,054	133,240	133,960	134,469	134,598	135,073

Figure 18. Current and Forecast Percentage of Departures by Passenger Aircraft Type.

Acft.	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
100	1.7	3.7	4.4	4.7	4.8	4.9	5	5.1	5.2	5.4	5.5	5.6	5.7
320	1.2	2.1	4.7	5.6	5.9	6.2	6.5	6.5	6.8	6.8	7	7.1	7.3
72S	31.9	36.3	37	35.7	35.3	32.4	30.7	27.9	25.8	22.8	20.3	17.2	12.6
733	8.5	12.2	12.2	12.7	12.7	12.7	13.1	13.5	13.9	14.2	14.5	14.9	15.5
734	2.9	3.5	4.1	4.5	4.6	5.4	5.7	6.2	6.2	6.1	6.1	6.1	6.1
735	0	0	0	0	0	0	0	0	0	0	0	0.1	0.7
73S	10.3	5.9	5.6	4.4	4.2	4.2	4.1	4.1	4.1	4.1	4	4	3.8
757	9.5	7.2	6.5	7.5	8.1	8.7	8.9	9.6	9.9	10.5	10.9	11.5	12.2
763	2.5	2	1.9	2	2	1.9	1.9	1.9	1.9	1.9	2.2	2.4	2.4
767	1.8	1.5	1.7	1.9	2.1	2.3	3.5	4.6	4.8	5.4	6.9	7.4	7.8
AB3	0	0.1	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
D10	2.9	1.4	0.8	0.8	0.8	0.7	0.2	0.2	0.2	0.2	0.2	0.2	0.1
DC9	15.3	11.3	9.1	6.8	5.2	4.7	4.2	3.4	3	2.9	2.9	2.8	2.7
F28	2.3	1.5	1	1	1	0.8	0.8	0.7	0.7	0.6	0.5	0.5	0.5
L10	1.6	2	1.4	1.4	1.4	1.4	1.2	1	0.6	0.5	0.4	0.3	0.2
M80	7.6	9.5	9.3	10.6	11.6	13.5	13.9	14.7	15.7	16.8	16.8	17.8	19.5
M90	0	0	0	0	0	0	0	0.2	0.9	1.5	1.5	1.9	2.2
Total	100	100	100	100	100	100	100	100	100	100	100	100	100

Note: Detail may not add to 100 percent because of independent rounding.

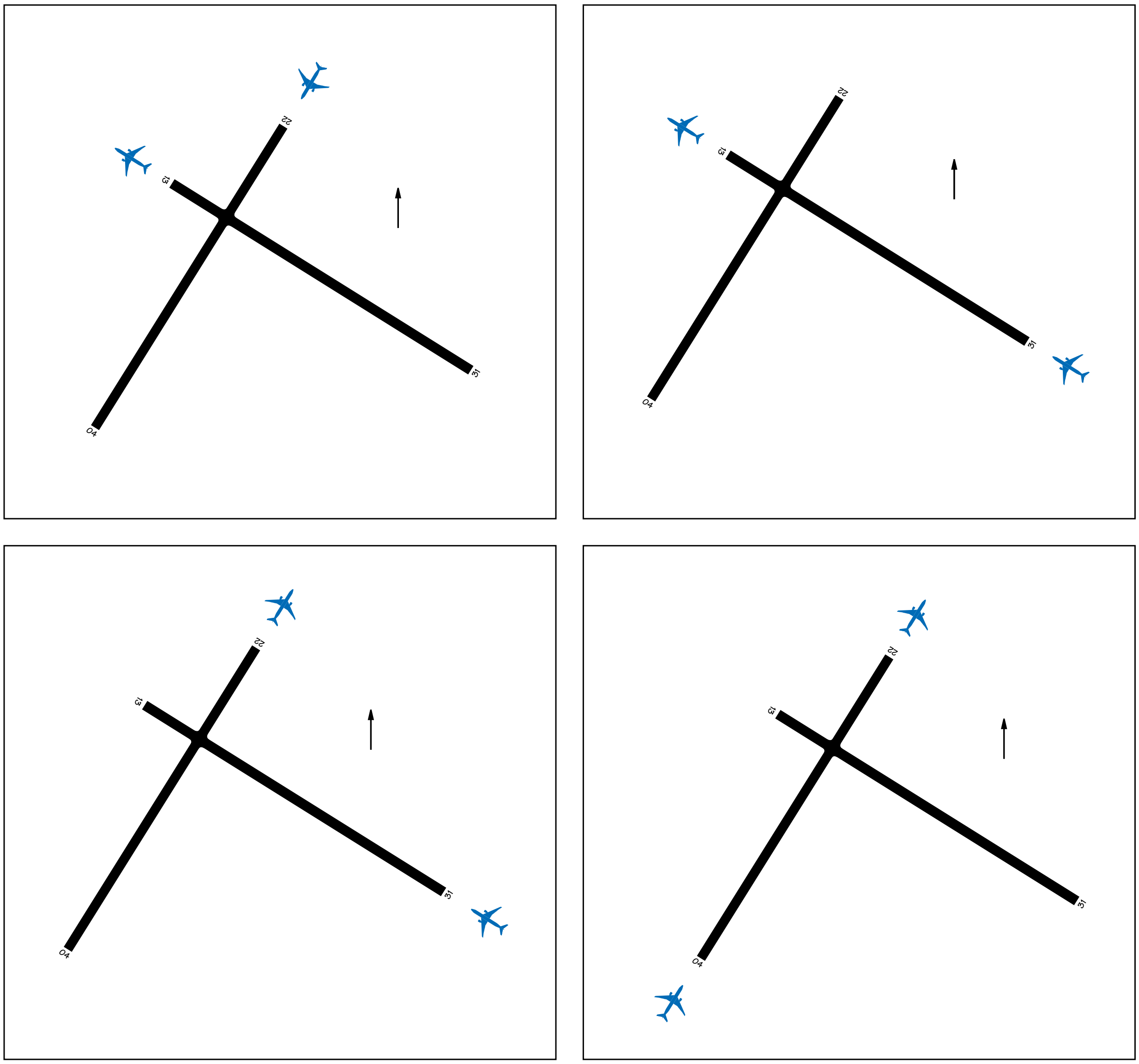
Simulation Inputs

Figure 19 delineates the general aircraft assumptions used in the model simulations, and Figure 20 illustrates the four runway configurations used.

Figure 19. Aircraft Assumptions.

Aircraft	B777	B767	B727	Commuters	Single Engine
Load & Unload Time (hours)	0.75	0.5	0.5	0.5	0.4
Turn Around Time (hours)	0.75	0.5	0.5	0.5	0.5
Unload Time (hours)	0.5	0.5	0.4	0.3	0.3
Load Time (hours)	0.5	0.5	0.4	0.3	0.3
Pushback Time (seconds)	420	420	180	10	10
Taxi Speed (knots)	18	18	16	14	10
Climb Speed (knots)	160	142	140	130	100
Weight 000 lbs.	420	255	200	150	100
Term Speed (knots)	250	250	220	200	180
Land Speed (knots)	135	130	120	110	85
Speed Variation (knots)	20	20	20	20	15
TD Distance (feet)	1,500	1,500	1,500	1,000	500
Land Deceleration (feet/sec/sec)	7	7	7	6	5
Land Distance (Feet)	7,000	7,000	7,000	5,000	5,000
Runway Occupancy Time (seconds)	60	60	52	52	45
Taxi Distance in Queue (feet)	300	240	205	200	140
Takeoff Acceleration (feet/sec/sec)	7	7	7	6	6
Approach Distance (nautical miles)	6	6	6	3	3
Approach Speed (knots)	145	140	130	120	95

Figure 20. Runway Configurations.



Appendix C

Computer Models and Methodology

Computer Models

The LaGuardia Airport ACE Action Team studied the effects of various operational alternatives proposed to accommodate the Boeing 777-200 folding-wing aircraft. The options were evaluated considering the anticipated increase in demand. The analysis was performed using computer modeling techniques. A brief description of the model and the methodology employed follows.

The Airport Machine

The Airport Machine is a PC-based, interactive model with animated graphics display that is used to evaluate proposed changes to airfield and terminal configurations, schedules, and aircraft movement patterns. It is an excellent tool for taxiway and gate analysis. Output from the model provides extensive data on delays and unobstructed travel times in aircraft movements.

The Collision Risk Model

The collision Risk Model (CRM) is a mathematical model and related computer programs which are used to estimate the probability of collision with obstacles by an airplane on an ILS approach and possible subsequent missed approach. The CRM estimates this probability from an entered description of a given current or proposed ILS approach procedure, and entered or iterated value for a proposed obstacle clearance altitude/height (OCA/H), and an entered description of the given current or proposed obstacle environment.

The CRM was developed by the Obstacle Clearance Panel as a result of an extensive data collection program followed by detailed mathematical analysis. The CRM is an important part of the criteria for ILS operations described in Part III of the PANS-OPS, Volume II, which acts as a working document for the procedures specialist in the design and construction of visual and instrument approach procedures.

Methodology

Model simulations included present and future air traffic control procedures, various airfield improvements, and traffic demands for different times. To assess the benefits of proposed airfield improvements, the FAA used only a west flow runway configuration derived from present and projected airport layouts. The projected implementation time for air traffic control procedures and system improvements determined the aircraft separations used for VFR weather simulations.

For the delay analysis, agency specialists developed traffic demands based on the Automated Radar Terminal System (ARTS), historical data, field observations, and various forecasts. Aircraft volume, mix and peaking characteristics were developed for each demand level (present and future). The estimated annual delays for the proposed improvement options were calculated from the experimental results. These estimates took into account the runway configuration, weather, and demand based on historical data.

Summary Data Package available as a Technical Note publication through the:

FAA Technical Center
Management Services Branch
Technical Libary, ACM-620A
Atlantic City International Airport, NJ 08405

Appendix D

List of Abbreviations

ACE	Airport Capacity Enhancement
APM	Airport Machine — computer simulation model
ARTS	Automated Radar Terminal System
ATC	Air Traffic Control
ATCT	Airport Traffic Control Tower
CAT	Category — of instrument landing system
FAA	Federal Aviation Administration
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
LBS	Pounds
LGA	LaGuardia Airport, New York, New York
MI	Miles
NM	Nautical Miles
RFP	Request for Proposal
SM	Statute Miles
TRACON	Terminal Radar Approach Control
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

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